

SEXUAL BEHAVIOR OF *HEMITAXONOUS DUBITATUS* (NORTON) (HYMENOPTERA: TENTHREDINIDAE)¹

Gordon Gordh²

ABSTRACT: Sexual behavior of this primitive tenthredinid sawfly is described. The male genitalia are illustrated.

DESCRIPTORS: *Hemitaxonous dubitatus* (Norton), Tenthredinidae, sawfly, courtship, sexual behavior, male genitalia.

The Holarctic sawfly genus *Hemitaxonous* Ashmead consists of 16 species, four of which occur in North America (Smith, 1969). The Old World representatives of the genus were revised by Naito (1971 a,b) who noted that they feed on ferns (except Aspidiaceae) and are generally monophagous. *Hemitaxonous* is a member of the Selandriinae, which, on the basis of morphological criteria, Ross (1937) considers the most primitive subfamily of the Tenthredinidae.

Little is known of the biology or behavior of *Hemitaxonous*. Recently, D.R. Smith collected larvae of *H. dubitatus* (Norton) on *Onoclea sensibilis* Linnaeus near Beltsville, Maryland. The following observations on the sexual behavior of this species are based on the material collected by Smith.

Materials and Methods — After feeding, the larvae dropped from the plant and crawled between laminae of cardboard provided for a pupation site. This species does not spin a cocoon, but it does seal the aperture through which it has crawled. A few days after all the larvae had dropped from the host plant, the cardboard was split, and the pupae were individually placed in # 000 gelatin capsules. All adults emerged within a 48 hour period and were *bona fide* virgins. Males and females were placed together in pairs in petri dishes and observed with the aid of a stereomicroscope. The duration of coitus was timed with a stopwatch. Nineteen coital episodes were observed, and over fifty courtship attempts were observed.

¹ Accepted for publication: August 18, 1975

² Systematic Entomology Laboratory, Agr. Res. Ser., IIBIII, USDA, c/o U.S. National Museum, Washington, D.C. 20560.

Results — Adults were removed from their gelatin capsules with a pair of forceps and placed in the petri dish. Females were always introduced into the dish first. I noticed that when the sawflies were touched with the forceps, or otherwise disturbed, they emitted a strong musky scent and did not struggle. After being released they often remained motionless up to 20 seconds.

Copulation always occurred on the side of the petri dish nearest the point of greatest illumination. Male approach was not complicated and consisted of the male's encountering the female on the substrate. He then climbed on the female's dorsum and vibrated his wings rapidly. During wing vibration the wings were held partly open and canted approximately 40-50 degrees. The time spent on the female's dorsum was 7.69 ± 3.14 seconds for 28 observations. With his wings still vibrating, the male then quickly moved off the female and assumed a position perpendicular to the long axis of the female's body and at the level of her thorax. The male's front and middle legs were on the substrate, but his hind legs were still on the female's thoracic notum.

The male then initiated genitalic probing of the female's mesosternum. During probing the aedeagus was exerted and the male's abdomen appeared "S"-shaped in profile. The dorsal margin of the middle terga of the male's abdomen conformed to a cross section of a contour of the female's thoracic venter and he continued to vibrate his wings. The duration of mesosternal probing was not established, but it was less than two seconds.

Next, the male began to move toward the apex of the female's abdomen, maintaining a right angle to the female's longitudinal body axis, continuing the genitalic probing near the female's sternal midline and holding the hind tarsi on the female's folded wings. At this point many courtship attempts were broken off when the female moved away. However, if the male reached the apex of the female's abdomen, he pivoted the longitudinal axis of his body 90 degrees so that the pair established a straight line with the apices of their abdomens appressed and their heads facing opposite directions. Insertion of the male's aedeagus into the female's bursa copulatrix was from this stance. During aedeagal insertion the male held his hind tarsi on the apical segments of the female's abdomen or on the anterior margins of her wings. The female's wings were held in repose over her abdomen, but the male continued to vibrate his wings. After insertion of the aedeagus, which often took several seconds, probably depending upon female arousal, the male removed his hind tarsi from the female, placed them on the substrate and ceased vibrating his wings.

Coitus lasted 70.63 ± 22.84 seconds for 19 pairs. During coitus each pair remained quiescent. The coital stance was such that each participant was a mirror image of the other: antennae were held parallel to the substrate, were motionless, and subtended an angle of approximately 80-100 degrees.

The male appeared to exert considerable control over the duration of coitus because several females were observed dragging males backwards around the container after the pair had been *in copulo* for over thirty seconds. I also noted females attempting to dislodge the males by pressing the hind basitarsi or apex of the hind tibiae against the male aedeagus, but this action was usually unsuccessful.

During insemination the female's pygostyli touch the male's eighth tergal plate apically. After disengagement the pair did not demonstrate interest in one another. Recently mated males did not exhibit sexual arousal (wing vibration and mounting) when placed with virgin females. However, 24 hours after mating, two males did mate with virgin females. Similarly, one female that had copulated with a male a few hours earlier, and was presumably inseminated, did allow a second male to copulate with her.

One male was rejected repeatedly by a virgin female, although she did permit him to mount several times. This female was subsequently killed in absolute alcohol, dried for several minutes and then placed in the container with the rejected male. The pair was observed continuously for 15 minutes and during that period the female's body elicited no sexual arousal from the male. The male was then placed with a live virgin female and copulation was observed after the pair had been together less than five minutes. Males have also been observed walking over thanatotic females and copulating with them several minutes later.

The genitalic embrace deserves comment. The female's ovipositor is short, less than 1/8th the length of the abdomen. The gonopore, which leads to the bursa copulatrix, is situated at the base of the ovipositor shaft (first and second valvulae combined) and at the level of the spiracles of the eighth tergum. During coitus the shaft of the ovipositor is elevated slightly and the base of the shaft is lowered and moved posteriorly slightly.

According to Snodgrass (1941), tenthredinoid male genitalia are characterized by the absence of parameral cupping discs. The parameres of *H. dubitatus* lack discs, but they are broad and their inner surfaces are concave. During coitus the parameres are pressed against the posterior margin of the female's seventh sternum, but they do not appear completely responsible for maintaining the strong genitalic grasp I observed. The strength of the genitalic grasp is probably due to the large spoon-shaped cuspis that is opposable to the enlarged toothlike digitus. The apical portion of the cuspis bears several denticles which probably aid in maintaining the grasp. (See figure).

I do not know what the digitus and cuspis grab because observation of their action was obscured by the male's seventh sternum. I attempted to kill pairs *in copulo* with alcohol and with ethyl acetate, but in each instance the insects separated before I could examine the genitalic embrace. However, dissection of several females revealed a lightly sclerotized membrane that was

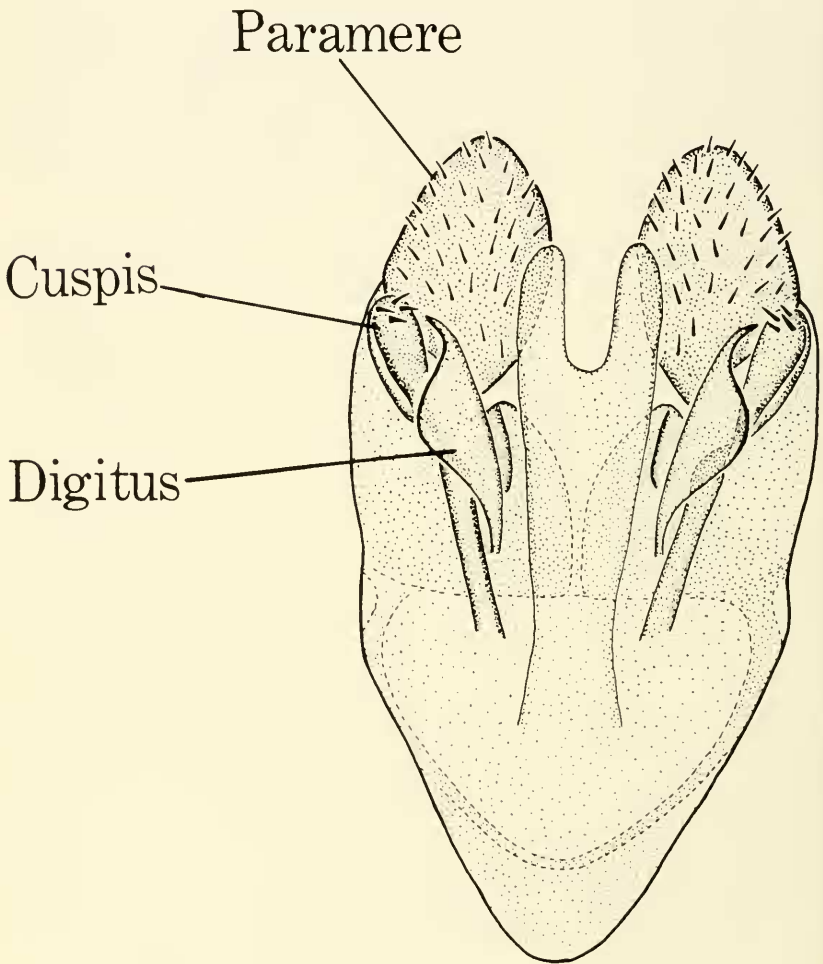


Figure 1. *Hemitaxonus dubitatus* male genitalia, dorsal aspect.

freely manipulatable, attached near the pygostyli and whose posterior margin conformed to the posterior margin shape of the female's pygostylar plate. Quite possibly the male maintains his grasp by opposing the digitus to the cuspis on the apical margin of this membrane.

DISCUSSION

Discussion — Although these notes are incomplete, they are intended to provide basic information about the courtship repertoire in the Symphyta and at the same time stimulate similar investigations of related taxa. Knowledge of sexual behavior in the Symphyta is woefully incomplete and as a consequence it is not possible to determine evolutionary patterns of courtship behavior for the Hymenoptera.

On the basis of male genitalia position, a fundamental dichotomy appears in the sawflies. Crampton (1919) and Boulangé (1924) have shown that male tenthredinid genitalia have rotated 180 degrees on the median axis. This condition also exists in *Xyela* (Xyelidae) and collectively these insects have been called "strophandrous" by Crampton. All other sawflies are called "orthandrous" because the male genitalia are not rotated.

Rotation of the male genitalia has caused modifications of sexual behavior. The tandem (back-to-back) coital stance appears commonly in the Tenthredinoidea and *Xyela* (Rohwer, 1915; Burdick, 1961). However, the orthandrous *Cephalcia fascipennis* (Cresson) (Pamphiliidae) male mounts the female, inserts his aedeagus, then rotates his body and assumes a tandem position (Eidt, 1965).

The evolutionary significance of genitalic rotation is unclear. Rotation has an effect on the copulatory stance and position of the male during aedeagus insertion. Additional and more careful observations of courtship in the Strophandria may provide clues as to the significance of rotation, especially when variations in the courtship repertoire, in male insertion stance, and in the tandem copulatory stance are determined for tenthredinoids. Male genitalia rotation and tandem copulation in *Xyela* suggests a polyphyletic origin of the phenomena, but careful investigations are needed before any conclusions are reached regarding the presumed aberrancy of *Xyela*.

The absence of intensive male antennal vibrations in *H. dubitatus* suggests that antennae do not play an active role in mediating sexual behavior in this species. Antennae are actively used in parasitic Hymenoptera (Gordh and DeBach, in prep.).

The conspicuous wing vibration pattern is stereotyped in this species, but it is not certain what function wings serve in sexual behavior. They may be acting as visual, tactual or chemical (pheromone dispersal) stimuli used to

arouse the female. Wing vibrations are common in the courtship patterns of parasitic Hymenoptera (Gordh and DeBach, in prep.).

The duration of coitus in the Symphyta is highly variable. Ries (1926) reported that copulation lasts 10 minutes in *Cephus pygmaeus* (Linnaeus), whereas Dahlsten (1961) reported that *Neodiprion* sp. remains in copulo for 100 minutes. *Hemitaxonus dubitatus* remains in copulo less than 90 seconds. It seems likely that insects are more vulnerable to predation during copulation because they are less mobile and therefore more susceptible to capture. Selection should thus operate to reduce the amount of time a pair spends copulating. However, this selective pressure would be modified if there were a functional necessity operating to prolong the copulation period. Manufacture and transfer of a spermatophore would be one instance in which prolonged copulation would be more beneficial than a short-duration copulation in which sperm transfer is incomplete or ineffective. I was unable to find a spermatophore when I dissected mated females of *H. dubitatus*.

LITERATURE CITED

- Boulangé, H. 1924. Recherches sur l'appareil copulateur des hyménoptères et spécialement des chalastogastres. Mém. Trav. Facul. Cath. de Lille Fasc. 28, 444 pp.
- Burdick, D.J. 1961. A taxonomic and biological study of the genus *Xyela* Dalman in North America. Univ. Calif. Publ. Entomol. 17: 285-356.
- Crampton, G.C. 1919. The genitalia and terminal abdominal structures of the males and the terminal abdominal structures of the larvae of "Chalastogastrous" Hymenoptera. Proc. Entomol. Soc. Wash. 21: 129-155, 4 pl.
- Dahlsten, D.L. 1961. Life history of a pine sawfly, *Neodiprion* sp., at Willits, California (Hymenoptera: Diprionidae). Can. Entomol. 43: 182-195.
- Eidt, D.C. 1965. The life history of a web-spinning sawfly of spruce, *Cephalcia fascipennis* (Cresson) (Hymenoptera: Pamphiliidae). Can Entomol. 97: 148-153.
- Gordh, G. and P. DeBach. Courtship behavior in the *Aphytis lingnanensis* complex, its potential usefulness in taxonomy, and a review of sexual behavior in the parasitic Hymenoptera. in preparation.
- Naito, T. 1971a. A revision of the genus *Hemitaxonus* in the old world, I (Hymenoptera, Tenthredinidae). Kontyû 39: 19-28.
- Naito, T. 1971b. A revision of the genus *Hemitaxonus* in the old world, II (Hymenoptera, Tenthredinidae). Kontyû 39: 77-82.
- Ries, D.T. 1926. A biological study of *Cephus pygmaeus* (Linnaeus), the wheat-stem sawfly. Jour. Agr. Res. 32: 277-295.
- Rohwer, S.A. 1915. The mating habits of some sawflies. Proc. Entomol. Soc. Wash. 17: 195-198.
- Ross, H.H. 1937. A generic classification of the Nearctic sawflies (Hymenoptera: Symphyta). Univ. Ill. Bull. 34: 1-173.
- Smith, D.R. 1969. Nearctic sawflies II. Selandriinae: Adults (Hymenoptera: Tenthredinidae). Tech. Bull. 1398, Agr. Res. Serv. U.S.D.A., 48 pp., 10 pl.
- Snodgrass, R.E. 1941. The male genitalia of Hymenoptera. Smiths. Misc. Coll. 99: 1-86, 33 pl.